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NASA Facts

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center

Astronaut Selection and Training

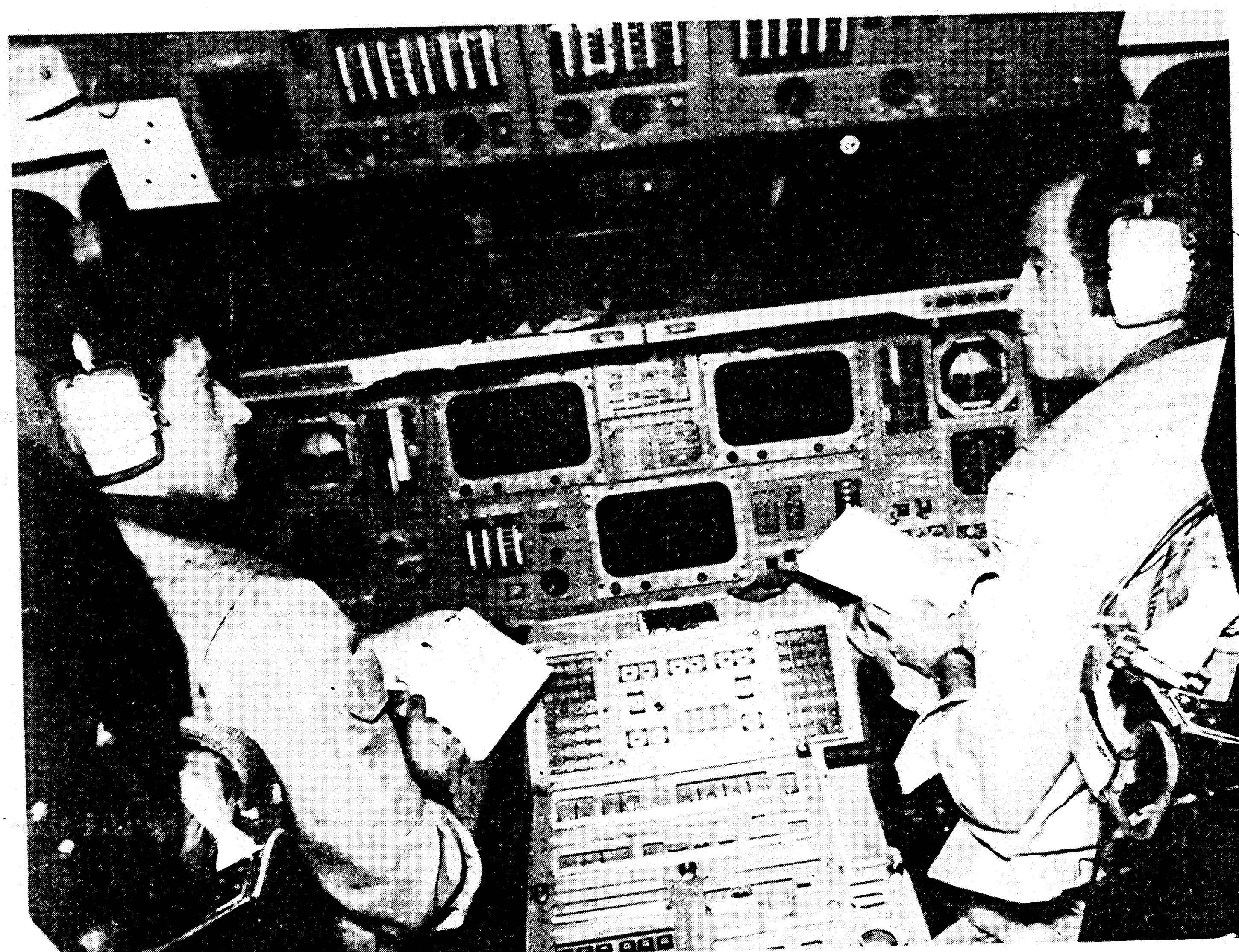
Spacemen of fiction—Jules Verne's travelers to the Moon, or the comic strip heroes Flash Gordon and Buck Rogers—were familiar characters midway through the 20th Century, but nobody could describe accurately a real astronaut. There were none.

Then in 1959 the National Aeronautics and Space Administration asked the United States military services to list their members who met specific qualifications. The search was underway for pilots for the exciting new manned space flight program.

In seeking its first space pilots, NASA emphasized jet aircraft flight experience and engineering training, and it tailored physical stature requirements to the small cabin space available in the Mercury capsule then being designed. Basically, those 1959 requirements were: Less than 40 years of age; less than 5 ft. 11 inches tall; excellent physical condition; bachelor's degree or equivalent in engineering; qualified jet pilot; graduate of test pilot school, and at least 1500 hours of flying time.

More than 500 men qualified. Military and medical records were examined; psychological and technical tests were given; personal interviews were conducted by psychological and medical specialists. At the end of this first screening, many candidates were eliminated and others decided they did not want to be considered further.

Even more stringent physical and psychological examinations followed, and in April 1959 NASA announced its selection of seven men as the first American astronauts. They were Navy Lieutenant M. Scott Carpenter; Air Force Captains L. Gordon Cooper, Jr., Virgil I. "Gus" Grissom, and Donald K. "Deke" Slayton; Marine Lieutenant Colonel John H. Glenn, Jr., and Navy Lieutenant Commanders



Astronauts John W. Young and Robert L. Crippen go over a checklist in the Space Shuttle mission simulator. Young, left, is crew commander for STS-1, the first in a series of orbital flight test (OFT); and Crippen is pilot.

Walter M. Schirra, Jr., and Alan B. Shepard, Jr.

Each flew in Project Mercury except Slayton, who was grounded with a previously undiscovered heart condition. After doctors certified that the condition had cleared up, Slayton realized his ambition to fly in space 16 years after his selection. He was a member of the American crew of the Apollo Soyuz Test Project in July 1975, the world's first international manned space flight.

More Recruiting

Three years after that first selection, NASA issued another call for Gemini and Apollo astronaut trainees. Experience in flying high-performance aircraft still was stressed, as was education. The limit on age was lowered to 35 years, the maximum height raised to 6 feet, and the program was opened to qualified civilians. This second recruitment brought in more than 200 applications. The list was screened to 32, then finally pared to nine in September 1962.

Fourteen more astronaut trainees were chosen from nearly 300 applicants in October 1963. By then, prime emphasis had shifted away from flight experience toward superior academic qualifications. In October 1964 applications were invited on the basis of educational background alone. These were the scientist-astronauts, so called because the 400-plus applicants who met minimum requirements had a doctorate or equivalent experience in natural sciences, medicine, or engineering.

These applications were turned over to the National Academy of Sciences in Washington for evaluation. Sixteen were recommended to NASA, and six were selected in June 1965. Although the call for volunteers did not specify flight experience, two of the applicants were qualified jet pilots and did not need the year of basic flight training given the others.

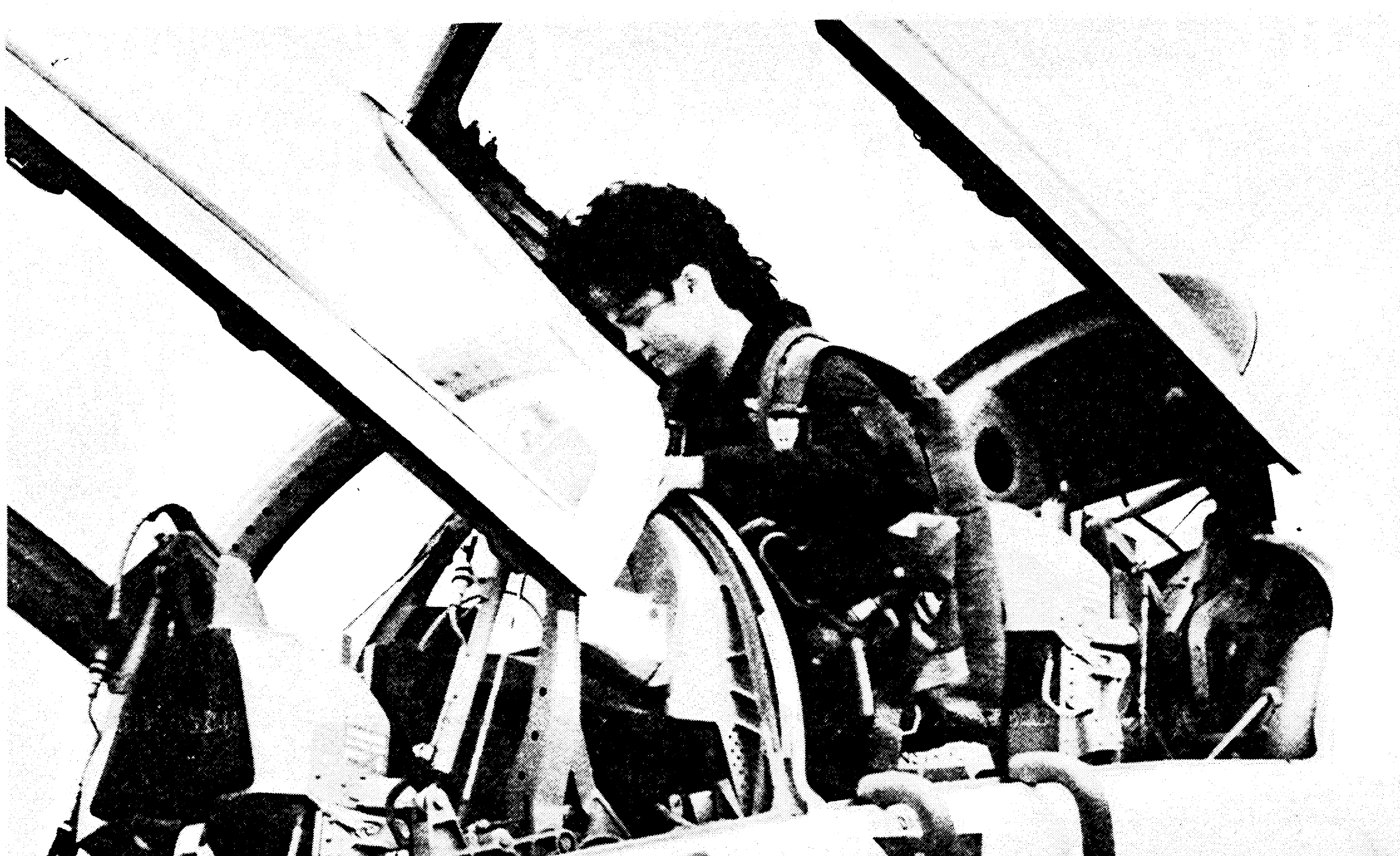
Another 19 pilot astronauts were brought into the program in April 1966, and 11 scientist-astronauts were added in mid-1967. When the Air Force Manned Orbiting Laboratory program was cancelled in mid-1969, seven astronaut trainees transferred to NASA.

Shuttle Era Astronaut Candidate Recruiting

The most recent group of astronaut candidates began a training and evaluation period in July 1978. Change of the astronaut candidates' status to that of astronaut became effective August 31, 1979. The new astronauts include 15 pilots and 20 mission specialists. Six of the latter are the first women to become astronauts in the United States space program.

Minimum requirements for pilots were a bachelor's degree in engineering, physical science, or mathematics with advanced degrees desirable, and at least 1,000 hours of first pilot time. High performance jet aircraft and flight test experience was highly desirable and they had to pass a NASA Class I flight physical. The height requirement was between 64 and 76 inches. For mission specialists the minimum requirements included a bachelor's degree in engineering, biological or physical science with advanced degrees or experience desirable. Passing a NASA Class II physical was required of the mission specialist and that they be between 60 and 76 inches in height.

On August 1, 1979, NASA announced plans to begin accepting applications for Space Shuttle astronauts on an annual basis. The period for submitting applications by civilians will, for 1979, begin October 1 and end December 1. Depending on the needs of NASA for pilots and mission specialists, a selection will be made from rosters of qualified applicants resulting from this announcement. The rosters will be established annually. Successful applicants selected from this 1979 effort will be asked to report to the Johnson Space Center in mid-1980 for a one-year training and evaluation program as astronaut candidates, after which pilot and mission specialist astronauts will be selected. Military applicants should apply through the parent military organization.



Pilots and mission specialists will spend many hours in various type aircraft. Pilots will maintain proficiency in T-38 aircraft and mission specialists will ride in the back seat. Both will use a T-38 to travel to other training sites and contractor facilities.

Pilot Candidates

Pilot candidates are required to have a bachelor's degree from an accredited institution in engineering, biological or physical science, or mathematics. Degree must be received by December 1, 1979, for applicants responding to the August 1, 1979 selection program. An advanced degree or equivalent experience is desired. Quality of academic preparation is important. To meet the minimum qualifications, an applicant must also have at least 1,000 hours pilot-in-command time in high performance jet aircraft. Flight test experience is highly desirable. The pilot applicant must be able to pass a NASA Class 1 space flight physical (similar to military and civilian flight physicals) to include the following specific standards:

Distant visual acuity: 20/50 or better uncorrected; correctable to 20/20 each eye.
Hearing loss not to exceed:

Frequency (H_z)	500	1000	2000
Loss (db)	30	25	25 per ISO, 1964 Standard

Blood Pressure: Preponderant systolic not to exceed 140, nor diastolic to exceed 90mm Hg, measured in sitting position.
Applicant height between 64 and 76 inches.

Mission Specialist Candidates

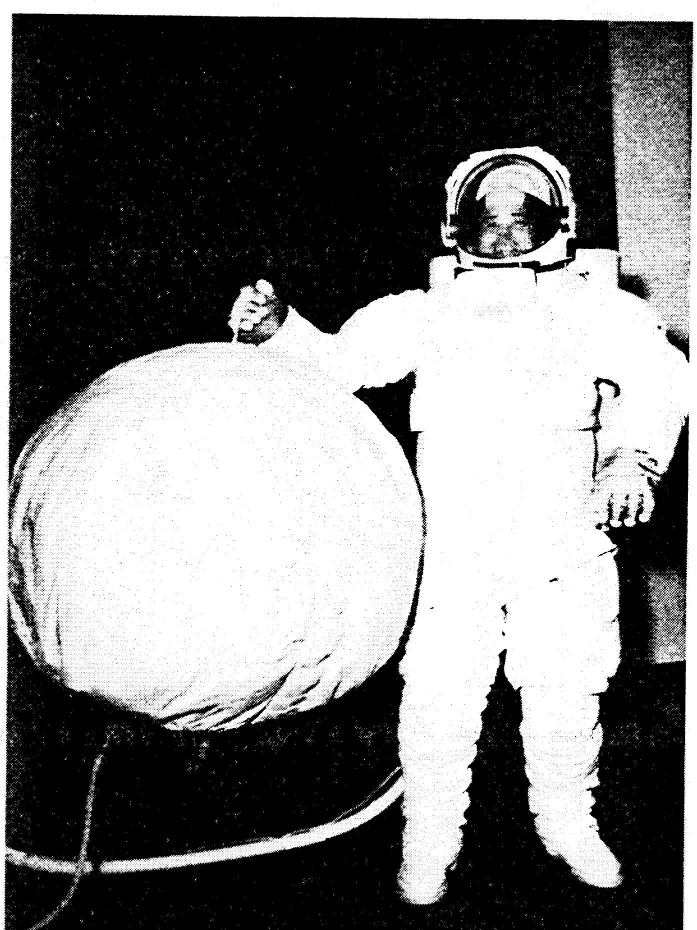
Mission specialist astronaut candidates must have a bachelor's degree from an accredited institution in engineering, biological or physical science, or mathematics. For the 1979 selection program, the degree must be received by December 1, 1979. Degree must be supplemented by at least 3 years relatable experience. An advanced degree is desired and may be substituted for the experience requirement (masters's degree = 1 year, Ph. D. degree = 3 years). Quality of academic preparation is important. Candidates must pass a NASA Class II space flight physical (similar to military and civilian flight physicals) to include the following specific standards:

Distant visual acuity: 20/100 or better uncorrected; correctable to 20/20 each eye.
Hearing loss not to exceed:

Frequency (H_z)	500	1000	2000
Loss (db)			
Better ear	30	25	25
Worse ear	35	30	30 per ISO, 1964 Standard

Blood pressure: Preponderant systolic not to exceed 140, nor diastolic to exceed 90mm Hg, measured in sitting position.
Applicant height between 60 and 76 inches.

Rescue of a fellow crewman is part of the schooling for a space pilot. Demonstrated here is the two-piece Shuttle spacesuit with integrated life-support backpack and the 39-inch diameter fabric rescue sphere in which payload specialists would be evacuated from a stricken spacecraft.



Simulators such as the Orbiter Aeroflight Simulator (OAS) provide a realistic tool for acquainting the pilots and mission specialists with the operation and flying characteristics of the Shuttle.

Education Requirements

Applicants for the Astronaut Candidate Program must meet the basic education requirements for NASA engineering and scientific positions. Specifically, successful completion of a standard professional curriculum in an accredited college or university leading to a bachelor's degree with major study in an appropriate field of engineering, physical science, life science, or mathematics.

The following degree fields which may be related to engineering and the sciences are *not* considered qualifying:

- Degrees in Technology; i.e., Engineering Technology, Aviation Technology, Medical Technology, etc.
- Degrees in Psychology (except Clinical, Physiological, or Experimental Psychology, which are considered qualifying).
- Degrees in Aviation. Aviation Management, or similar fields.

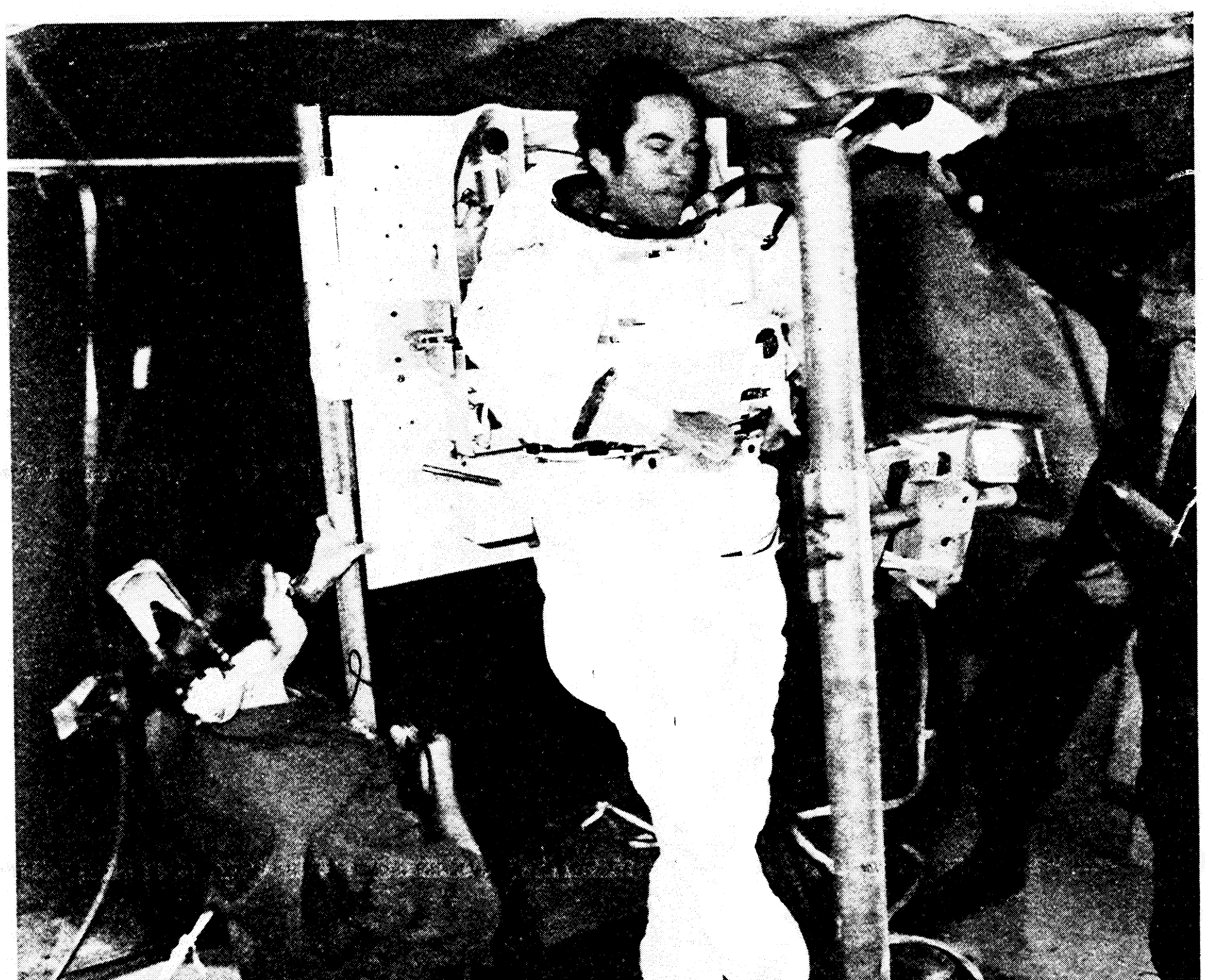
Space Transportation System

The Space Transportation System has been developed to expand our capabilities in space and to reduce the costs of space operations. The System's Space Shuttle provides payload specialists with a habitable working environment and support services with a minimum of space flight training, allowing them to focus on technical or scientific objectives.

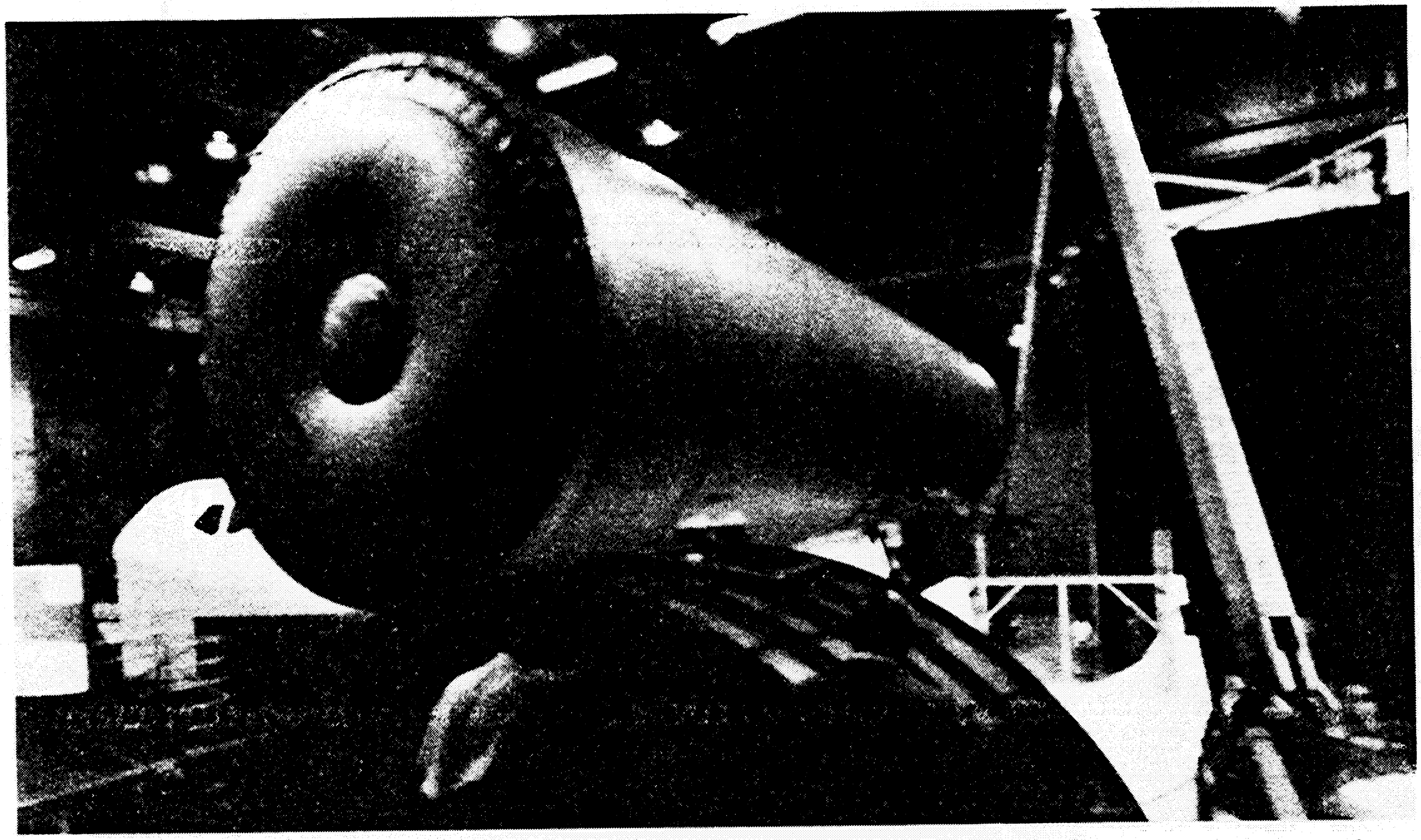
Shuttle Crew Positions

The Space Shuttle orbiter crew positions are commander, pilot, mission specialist and payload specialist. The commander and pilot fly the orbiter. A mission specialist will normally be assigned as a spacecraft-proficient crewmember who is also skilled in payload operations, and who can assist the payload specialist(s) to function effectively. One to four payload specialists may be assigned, depending on payload.

The payload specialist will receive the majority of his or her training from the payload developer; however, he or she will receive approximately 150 hours of training at the Johnson Space Center. This training familiarizes the payload specialist with the STS (space transportation system) vehicle and payload support equipment, crew operations, housekeeping, and emergency procedures related to his or her flight.

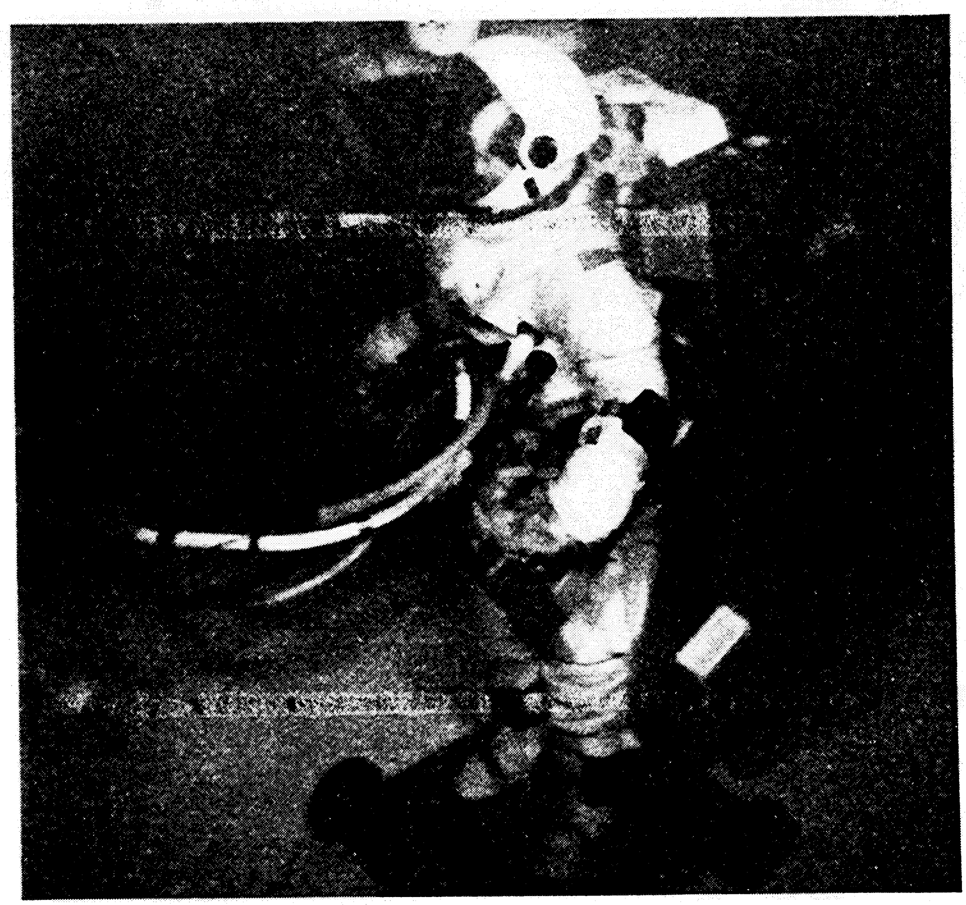


The STS-1 crew, taking advantage of a brief period of zero gravity afforded aboard a KC-135 aircraft flying a parabolic curve, goes through a spacesuit donning excerise of the hard-torso extravehicular mobility unit (EMU).



Handling a bulky cargo in the weightlessness of space can be a tricky operation. Here, a helium-filled 15x60-foot balloon simulates a Space Shuttle payload for a ground-based version of the Orbiter's remote manipulator arm. Future payload specialists will train on the device to learn to become space "stevedores."

Training of astronauts includes operations such as this test of the Shuttle manned maneuvering unit (MMU) which is scheduled for use aboard the orbiter. Underwater tests such as this are part of the detailed astronaut training program.



Back to School

Once selected to train as an astronaut, it's back to school studying basic science and technology courses, such as mathematics, meteorology, guidance and navigation, astronomy, physics, and computers.

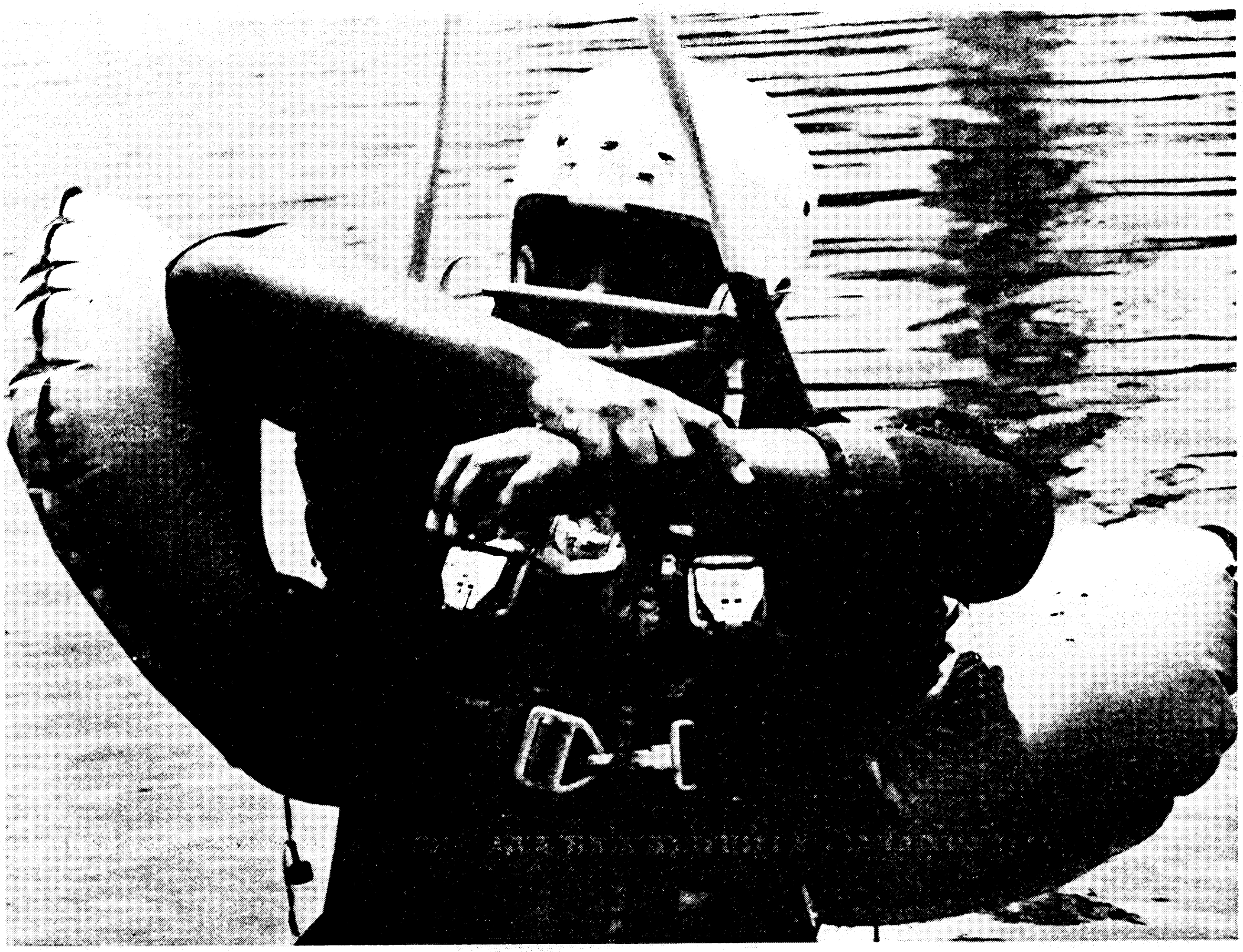
Training to familiarize astronauts with the environment of space includes weightlessness. Periods of up to half a minute of zero-g is simulated when a 4-engine jet KC-135 aircraft, modified for astronaut training, is flown "over the top" of a parabolic path to give an effect similar to that felt in a rapidly descending elevator. During this "zero gravity," the astronaut practices activities, such as drinking, eating, and using various types of equipment. Longer periods of weightlessness are simulated under conditions of "neutral buoyancy" in a specially designed water tank large enough to hold full-scale mockups of spacecraft components and equipment.

To become accustomed to working in a pressurized spacesuit, astronauts spend many mission training sessions in the suit.

Shuttle pilot astronauts will land their vehicle much like an aircraft on a runway. In addition to the simulators, conventional and modified aircraft will be utilized in the practice approach and landings. A 4-engine jet KC-135 will be used to provide experience in handling a large aircraft. Modified Grumman Gulfstream II aircraft, designated "Shuttle Training Aircraft" (STA), to simulate the handling characteristics of the orbiter, will be flown by the astronauts from 35,000 feet altitude to landing.

Further astronaut responsibilities include keeping abreast of spacecraft, payloads, and launch vehicles design, development and modification activities. This requires their presence at many engineering conferences and reviews at the Johnson Space Center, where the astronauts are assigned, or at other NASA centers or contractor plants. Because of other training requirements, and because of the complexity of the program, no one astronaut can be expected to be knowledgeable of each day-to-day change, so one or more astronauts are assigned specific areas of the program. Periodic reports to the rest of the group keep everyone up-to-date.

In addition, the astronaut is required to keep flying skills sharp and physical condition excellent—both will be called upon often in space flight. Flight readiness is maintained through regular use of high-performance jet aircraft assigned to the Johnson Space Center and based at nearby Ellington Air Force Base. Physical conditioning is more a matter of individual need and preference. Gymnasium facilities are available. Keeping in excellent physical condition also applies to the mission specialist.



As part of water survival training, one of the astronaut candidates is shown taking part in a simulation exercise which prepares the participant for helicopter retrieval following a parachute landing in water. The lift device is suspended from a structure over the water and an electric winch lifts the participant, simulating a helicopter pickup.

Flight Assignments

When an astronaut is assigned to a flight crew his or her schedule really gets busy. Crews are named for specific flights well in advance of the launch date. For the Space Shuttle program, the flights will come at more frequent intervals and several crews will be in training at the same time.

Each crew receives cross-training so that at least one crewman can handle the most critical duties of each associate. In addition, for the early operational test flights, a second or "backup" crew will go through identical training. Thus an ill or injured crewman can be relieved in flight or replaced before the flight without compromising the mission.

Each crew takes part in spacecraft reviews and test programs which lets each crewman become familiar with a spacecraft. These reviews include briefings on spacecraft, spacecraft systems, and guidance and navigation.

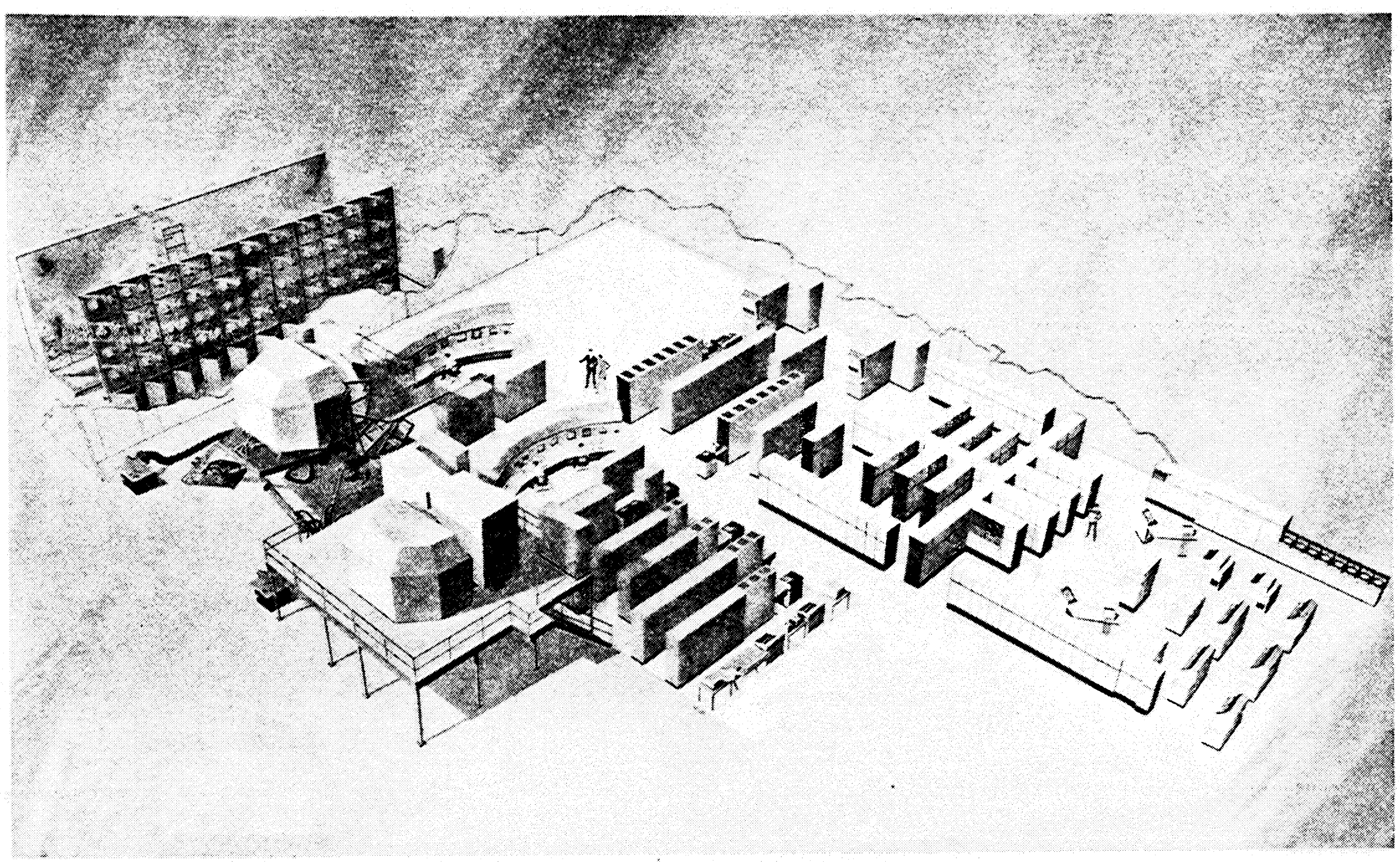
The tempo picks up as the astronauts begin working with the various simulators, first to learn the individual tasks that will be required to fly the spacecraft, then to put them all together in sequence that will be followed in the actual mission.

The simulators provide extremely realistic working conditions. The spacecraft interiors are duplicated, the instruments, such as guidance and navigation displays, are programmed to give the same readings they would in flight. Even out-the-window views of the Earth, stars, payloads, and the landing runway are projected onto screens where the spacecraft windows would be. During earlier programs, the simulated conditions were so accurate that most astronauts came back from a mission feeling they had made the same flight many times before.

Training reaches its peak several weeks before the scheduled flight when the mission simulator is linked with Mission Control Center and with an also-simulated version of the network of tracking stations. Crews and flight controllers practice the entire mission in a joint training exercise that proves everything ready for the real thing.

In between their simulator sessions, the crewmembers will continue to keep themselves up-to-date on the status of the spacecraft and payloads for their mission. They also practice activities related to the mission, such as deploying and retrieving payloads, operating experiments, and extravehicular activity. They train in celestial observation—important to special navigation, and in the performance of some of the scientific experiments. They learn detailed scientific equipment design and operation in gathering scientific data. And, all the while, each astronaut continues to maintain individual flight and physical status.

Even when the flight is completed, their job is not done. The crewmembers spend several hours or days in debriefing—recounting their experiences for the benefit of future crews to help determine whether spacecraft systems, payload handling techniques, or perhaps training procedures, might be improved. Newsmen also receive a detailed post-flight briefing by the crew. And after a brief "vacation," the studies and training are resumed that eventually may lead to another flight into space.



The Shuttle Mission Simulator (SMS) is the major simulation device used to support crew training requirements for operation of the Space Shuttle systems. Starting at far left, is the topography relief model of the landing site that is relayed via three-dimensional TV to the simulator windows. Next are the crew stations with the six-degrees-of-freedom motion simulator and the fixed base simulator. In front of the crew stations are the instructor consoles. The remainder of the complex consists of visual generation equipment, computers, and interface equipment to tie the simulations with the Mission Control Center.

There is no "going around" in landing a Shuttle orbiter, and orbiter crews get realistic practice in steep, dead-stick descents in modified aircraft. Drag-producing devices installed on NASA's modified twin engine jet steepen the airplane's glide angle and control the approach speed to duplicate those of the orbiter after it enters the atmosphere following an orbital flight.

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